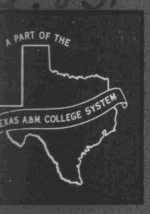
Bulletin 831



· Corn Meal in the · Food Supply of Texans

April 1956

TEXAS AGRICULTURAL EXPERIMENT STATION

R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS

DIGEST

Several agencies conducted a study of the place of corn meal and grits in the diet of Texans. These agencies included: the Texas Agricultural Experiment Station, Texas Agricultural Extension Service, Texas State College for Women, Texas Technological College, University of Texas, North Texas State College, Texas Home Economics Association, Texas Dietetic Association and Texas State Nutrition Council.

The cooperators were motivated by their mutual interest in a current nutrition problem — to determine how corn meal and grits will be of the greatest possible dietary benefit to Texans.

This bulletin gives information chiefly about corn meal since the place of grits was reported in Bulletin 753 of the Texas Agricultural Experiment Station. It illustrates voluntary sustained cooperation among educational agencies.

Information has come from many sources: 180 millers, 39 grocers, over 1,600 families and many more individuals, a number of college dormitories, hospitals, school lunchrooms and research in five institutions of higher education in Texas.

Findings:

1. Corn meal is used extensively in Texas. Amounts consumed vary greatly—from 0.4 pound per person per month by families in large cities to 2.6 pounds among rural and small city families. The State average was 1.2 pounds monthly.

2. The chief source of corn meal is the grocery. Grocers' estimates ranged from one-fifth as much corn meal as flour sold, to equal amounts of the two cereals. Purchases of corn meal are based chiefly on color; little or no attention is given to removal of germ and bran or to enrichment. Some, but not nearly all of the corn meal available in Texas is enriched.

3. Corn bread is the favorite preparation of corn meal. Proportions of ingredients in Texas corn bread vary greatly. Three standardized recipes were required to represent the preference of some housewives for sour milk, of others for sweet milk and for the use of flour with the meal in some homes. All institutional recipes used sweet milk and flour with the meal.

4. Corn bread of high-eating quality results from the standardized recipes based on the modal proportions of ingredients in 85 home recipes except that soda and baking powder were less than modal. Institutional corn bread made by a standardized recipe based on 29 recipes from dormitories, hospitals and lunchrooms was good.

5. Enriched corn meal has about four and one-half times as much thiamine as the corresponding non-enriched. In the corn breads made from these meals some with enrichment, others without, the enriched had one-third more thiamine.

6. The absolute amount of thiamine in corn bread depends first on the amount in the meal, egg and milk it contains, then on the amount lost while baking.

7. The thiamine in the bread as a percentage of that in the batter will be approximately the same whether the bread is made with enriched or non-enriched meal, with yellow meal or white meal, with or without flour, with sweet milk or with sour milk and the proper proportion of soda, and baked as a loaf 1 inch thick. The corn breads made with meals enriched in the laboratory averaged 86.8 percent as much thiamine as the batter, and 78.9 percent when made with commercial meals.

8. Enriched corn bread eaten in the amount estimated for one person at one meal (4.6 ounces) provides 17 to 25 percent of the recommended daily allowances for men and women 25 to 65 years of age.

9. Enriched corn bread contributes indirectly to a good diet through foods with which it is frequently eaten—meat, buttermilk and such vegetables as red beans, green onions, blackeye peas, turnips and greens and cabbage. Some of these accompanying foods supply vitamins other than the B group, others supply amino acids which are low in corn meal.

10. The greater food value of enriched corn meal over non-enriched is demonstrated by the greater thiamine content in the self-selected diet of college women when the corn bread was made with enriched meal, and by the better growth of rats when their rations contained the enriched meal.

11. The greatest benefit from corn meal can be derived only if in sour milk bread the proper proportion of soda is used (½ teaspoon to 1½ cups of milk) and if the corn meal used is enriched. The best way to assure Texans of enriched corn meal is by a legal requirement as is done for wheat flour, bread and oleomargarine.

12. The educational campaign in progress should be continued toward the goal of the greatest nutritional benefit from corn meal.

CONSECUTIVE STEPS IN THE COOPERATIVE UNDERTAKING

Steps	Participants
1. Survey (by counties) of the number of Texas mills which grind corn for human consumption, and millers' estimates of number of bushels of corn ground annually.	Texas Agricultural Extension Service.
2. Compilation of information on extent to which corn meal is eaten by Texans and sources and kinds of meal.	Research Committee[1] of the Texas State Nutrition Council, with the assistance of the Community Nutrition Section of the Texas Dietetic Association.
3. Inquiry as to the ways in which Texans prepare and eat corn meal and grits.	Community Nutrition Section of the Texas Dietetic Association, through special committees.
4. Collection of recipes for corn bread:	
Homemade, from Texas homes widely scattered over the State.	Research Committee of the Texas State Nutrition Council, with the assistance of the home economics students in their respective institutions.
Institutional, from Texas college dormitories, hospitals, and lunch rooms.	Graduate students of Texas State College for Women.
5. Analysis of proportion of ingredients in corn bread recipes collected, in effort to identify "Texas corn bread."	Department of Rural Home Research, Texas Agricultural Experiment Station, as part of the work in Research and Marketing project 603, and graduate students at Texas State College for Women.
6. Development of standard recipes for laboratory use.	
Before the analysis of collected recipes was available.	Texas Technological College.
Based on proportions in collected home recipes.	Department of Rural Home Research and graduate students at Texas State College for Women.
Based on proportions in collected institutional recipes.	Graduate students at Texas State College for Women.
7. Testing of quality of corn bread made by standardized recipes.	
Homemade	Persons trained in foods and cookery at Texas Technological College; staff members of the Department of Rural Home Research, food specialists of the Texas Agricultural Extension Service, local home economics homemakers; foods classes of North Texas State College and the University of Texas; and Texas homemakers reached through county home demonstration agents.
Institutional corn bread	Students in college dining halls at Texas State College for Women.

(Continued on page 4)

[1]Composed of one nutritionist each in the Texas Agricultural Experiment Station, North Texas State College, Texas Technological College, Texas State College for Women and University of Texas.

CONSECUTIVE STEPS IN THE COOPERATIVE UNDERTAKING — (Continued)

Steps	Participants
8. Experiments conducted	Under direction of the five members of the Research Committee of the Texas State Nutrition Council, each working in her institution's laboratories.
On retention of thiamine, riboflavin and niacin in corn meal and grits preparations.	Texas Technological College and the University of Texas, thiamine in corn bread; Department of Rural Home Research, all vitamins and all preparations included in the experiments.
On rat growth as affected by enriched versus non-enriched corn meal.	Graduate students in the Nutrition Department at Texas State College for Women.
On thiamine content of self-selected diets of college women as affected by enriched versus non-enriched corn bread.	Graduate students and students in home management houses at North Texas State College.
9. Educational campaign, in progress, with objective of making all Texans *want* enriched corn meal and grits, of inducing millers and merchants to provide Texas consumers with these enriched products, and interesting members of the Texas Legislature in the legal requirement of corn meal and grits enrichment.	Texas Agricultural Extension Service, Texas Dietetic Association, Texas Home Economics Association, Texas State Nutrition Council, Texas Agricultural Experiment Station, and college departments which have had a part in the cooperative undertaking.

CONTENTS

Corn Meal in the Food Supply of Texans

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AMERICANS BECAME MORE HEALTH AND NUTRITION conscious during the second World War than ever before. A national nutrition program including flour and bread enrichment came to a head. In time of stress, War Food Order No. 1 requiring white bread enrichment accomplished overnight what had been set as a long-time goal. Texas (1943) was one of the first states to pass a law making permanent the enrichment of flour and white bread.

When more than 20 states had such a law and when 5 states required the enrichment of degermed corn meal and grits, Texas nutritionists and dietitians thought it time to consider whether enrichment of these cereals might be a problem in Texas. The question called for information on the importance of corn meal and grits in the diet of Texans, their source, the quantity used, the factors affecting quantity, the ways in which they are prepared for eating and the effect of cooking on the nutrients they contain.

Some professional agencies especially interested in raising the nutritional status of Texans sponsored a plan in 1946 to get such information (33). This publication is a report of that cooperative undertaking.

The agencies which participated in the consecutive steps taken to obtain data of various kinds and to make practical application of the findings are shown on pages 3 and 4.

SURVEYS

Scope of Inquiries

Some of the desired information on the use of corn meal and grits by Texans was available from dietary studies which had been conducted for broader purposes (10, 29). A number of surveys (1, 2, 4, 14, 16, 20, 23, 30, 31, 32, 34) also were conducted to meet the specific needs of this cooperative undertaking. In every investigation, an effort was made to have those giving information comprise a representative sample of the population group being studied. Methods used to obtain information included questionnaires, personal interviews and current records kept by housewives. Where special committees functioned, each member obtained the desired information in her locality; the whole committee report represented different regions of the State. Such was the case with visits to 39 stores in five localities (32), inquiries on ways of preparing corn meal and grits (31) and with the collection of recipes (30).

Each county having a home demonstration agent was included in the survey of mills (24). The agent personally obtained and reported the information for her county.

All students then in college dormitories and in home management houses (6, 22) at North Texas State College, (NTSC) were included in the study. Written records of the desired information were kept.

The 63 families in the dietary study in Lubbock (10) were selected at random from different sections of town to represent all economic and social groups. The inventory method was used to determine a week's food consumption by these families.

The study of the food supply of 389 rural families (29) covered three tenure groups—owners or operators, renters (including croppers) and wage laborers—of both the white and the Negro population. Random selection of families was made in five counties representing three regions of the State. The Farm Security Administration and the Texas Agricultural Extension Service assisted with the selection in all regions. The Agricultural Adjustment Administration (now the Agricultural Stabilization and Conservation Office) also assisted in Brazos County. Information was obtained from these families through personal interview and a questionnaire was filled out at the time by the investigator.

The several surveys made by the Texas State College for Women (TSCW) (1, 2, 4, 14, 16, 20, 23, 34) emphasized statewide coverage and participation by native Texans, chiefly third generation. Two groups of Texans furnished data about food habits: 875 students at TSCW representing their families and 228 housewives with whom the investigators had some previous professional or friendly relation. The 657 native Texans in the first dormitory group of students were voluntary subjects. The 218 students who took part in other surveys were home economics majors. The groups of housewives contacted directly were representative of the Texas population (1950 census) (26) in the division between

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urban and rural families. The one group for which information on income was obtained (102 families in Collin county) was somewhat overweighted with moderate income people, 48 percent in comparison with 35 percent for the State. It seems likely this also is true among families of students attending a State college. However, this overweighting in the moderate income class probably does not affect the reliability of the conclusions concerning the use of corn meal and grits by Texas families.

The wide geographic distribution of the surveys is shown in the outline map of Texas (Figure 1) (7). The Roman numerals indicate the six geographic regions in which the 875 TSCW students lived, distribution by percentages of the total group being 23, 20, 29 and 17, respectively, for regions I, II, III and IV, and 8 and 3 percent for regions V and VI. Additional symbols give the approximate location of the counties or cities in which other surveys were made.

Findings in the Surveys

Amount of Corn Meal Used

Twenty-nine of the 39 grocers were asked to compare the amount of corn meal sold with wheat flour. Their estimates varied from one-fifth as much corn meal as flour to equal amounts of the two cereals.

The 63 families in Lubbock (population 40,000 in 1943) consumed approximately 20 percent as much corn meal as wheat flour. Ten to 20 percent as much corn meal as flour was used over

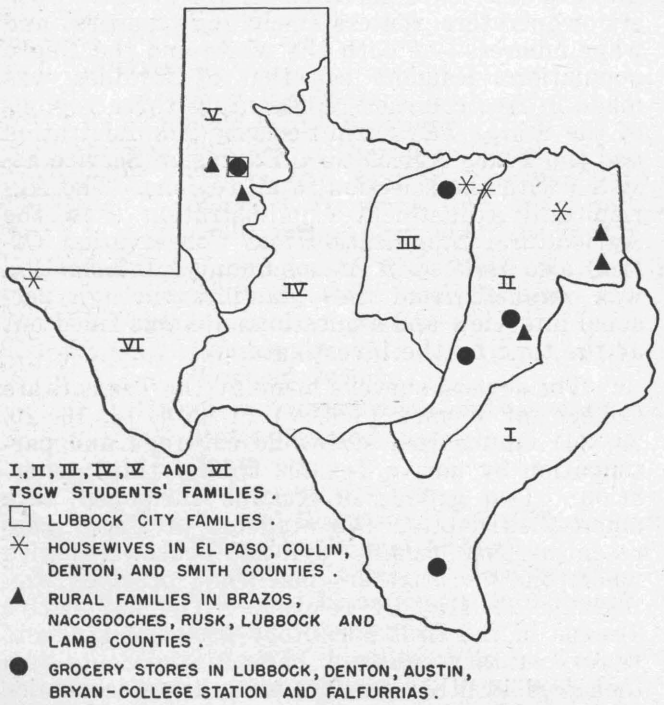

Figure 1. Geographic distribution of the surveys. Map derived from map in Chambers, "The Geography of Texas," 1946 (7).

the same period of time in three dormitories of NTSC.

Among the 389 rural families, the ratio of corn meal to flour was 1:1.5 for white and 1:1.6 for Negro. The average amount of meal was 1.6 pounds per person per week.

The rural families in the group represented by 140 students at TSCW (23) estimated that their corn meal consumption averaged 1.6 pounds per person per month. The records kept by the 102 rural families in Collin county (14) showed an average 2.6 pounds per person per month. Among these two groups of families, those in small cities averaged 1.3 and 1.8 pounds per person per month, respectively. The average corn meal consumption for families in large cities was only 0.4 pound per person per month. Based on a month's record of consumption of corn meal, flour and commercial bread by families in Collin county, the ratio of meal to flour was 1:2.3 for rural low income families (less than $2,000 per year) and 1:5.0 for urban high income families.

Source and Kind of Corn Meal and Grits

Reports from 182 counties showed mills grinding corn for human consumption in 71 of the counties (24). Bushels of corn ground annually (1946) ranged from 10 to 1,126,000; 43 mills exceeded 1,000 bushels and 13 ground 10,000 bushels or more. Very little of the ground corn went directly into Texas homes.

Nearly all of the 389 white and Negro rural families (29) bought their corn meal at the grocery in packages of less than 25 pounds. Package sizes in 19 of the stores visited (Austin, Bryan-College Station and Falfurrias) were: meal, 1¼, 1½, 2, 5, 10 and 25 pounds; grits, chiefly 1½ pound packages, although 1 store also carried the 3-pound size. The 5-pound package of meal was found most frequently, but the 10 and 2-pound packages also were common. The grocery was the main source of meal among Collin county families (14, 34)—92 percent for rural, 95 percent for towns and 100 percent for small cities. The 5-pound packages were bought by about half of the rural group and small town families, but the most populous localities preferred the 1-pound size. About one-fourth of the rural families bought the 10-pound size, while small-town families bought three to four times as many 1-pound as 10-pound packages.

Committee members visiting 39 stores in Lubbock, Denton, Austin, Bryan-College Station and Falfurrias found 25 brands of corn meal on the shelves. Seventeen of these brands were from Texas mills. The three brands of grits found came from out of state. Most of the meal was degermed "cream meal," but some stores handled a Texas brand of rock ground whole meal.

The volume of white meal on the shelves was considerably greater than that of yellow meal in the 39 stores. The families of 657 native Texas

students at TSCW indicated that the color of meal was the chief basis of choice; white or yellow was bought according to family preference. Among 228 housewives (2), 143 rural and 85 urban, 2.3 times as many used white as yellow meal; in the statewide distribution of families of students, 2.2 times as many used yellow as white meal. Use of yellow meal (2, 4, 16, 34) increased from east to west over the State. Ratios of yellow to white by region (Figure 1) were 2.0:1 (I and II), 2.6:1 (IV), 3.1:1 (V) and 7.6:1 (VI). White grits were more commonly used than yellow.

In all 39 stores (32) there were 68 brands of enriched meal and 92 of non-enriched; of grits, 38 enriched and 6 non-enriched. Grocers said that most customers seemed unconcerned about enrichment of corn meal and grits. Among the 389 white and Negro rural families in three regions of the State (29) two-thirds did not know whether they bought degermed or whole meal and half did not know whether the meal was enriched.

Ways of Preparing Corn Meal and Grits

Information was obtained from homes, school lunchrooms, cafeterias, cafes, restaurants, hospitals and dormitories (31), on ways of preparing corn meal and grits. Fourteen ways of using corn meal were mentioned. Corn bread as a loaf, muffins, sticks and dressing, constituted half of the total number of times the different ways were mentioned. Topping for hard rolls and breading for fish, liver and okra were common uses. Pone, brown bread, griddle cakes, and mush as cereal, a vegetable or fried, and in spoon bread or tamale pie were other ways reported. All eight ways mentioned for preparing grits required boiling. Most commonly, boiled grits were eaten as cereal, or as a rice or potato substitute along with eggs, meat or cheese. Grits served as an "extender" in scrapple and tamale pie, or when cold were sliced and fried.

Corn bread was baked as a loaf by half of the families of 73 students at TSCW and the Collin county families (14), and was baked as muffins more often than as sticks by the remainder of the families. A great variety of utensils was used for baking. Equally common were skillets (three-fourths of them 8 to 10 inches in diameter) and cake pans, (over half with a bottom area of 60 to 84 square inches), but dimensions of rectangular pans were exceedingly variable. The material of untensils in order of preference included cast iron (40 percent), tinned iron (27 percent), aluminum (19 percent), steel (10 percent) and glass (4 percent). Pans seemed to be chosen to give a loaf of desired thickness and crust quality. For every three families preferring thin crust, two families preferred thick. Bread according to the kind of cereal used and the frequency of serving in their homes was listed by 657 students at TSCW (2). Wheat bread was first for 92 percent of the homes, corn bread first for 5 percent, second for 30 percent and third for nearly 50 percent.

Collection of Corn Bread Recipes

Many Texas homemakers contributed their recipes for corn bread on personal request. Most of the first 85 recipes collected (30) were from East, North-central, South-central Texas and the High Plains. The last 26 recipes (16) came from the Trans-Pecos (El Paso) region. Ingredients varied markedly. There was an evident division of preference between sour and sweet milk, and between the use and non-use of sugar and of flour. In general, housewives of Southwest Texas used more fat, about half of them more egg, and they baked thicker loaves for a longer time, than those in other parts of the State.

Personal requests for their corn bread recipes were granted by 29 college dormitories, hospitals and school lunchrooms (1). Institutional corn bread called for sweet milk only, for sugar, more flour, baking powder and fat, and less egg than the standardized recipes based on those used in 85 homes.

LABORATORY STUDIES ON CORN MEAL AND CORN BREAD

Enrichment of corn meal and grits materially increases their vitamin content in the raw state. A previous report (25) from one of the participating laboratories noted that enriching corn meal to a level slightly above minimum federal standards increased the thiamine content to 4.7 times, the riboflavin to 3.7 times and the niacin to 4.3 times as much as the corresponding non-enriched meal. Without enrichment, raw grits were practically devoid of thiamine. Enriched grits contained 5.0 times as much riboflavin and 7.0 times as much niacin as the non-enriched. After enrichment, raw corn meal and grits have the same vitamin content per unit weight.

Since people do not eat raw corn meal and grits, the real benefit of enrichment depends on their vitamin content after cooking. Most of the laboratory work was done on corn bread, because surveys showed it is the favorite corn preparation of Texans. Each of the five participating laboratories conducted such studies with corn bread as best suited their respective situations as to available time, laboratory facilities and qualified personnel. Notwithstanding the resulting diversity in the contribution by the different laboratories, all work was directed toward the determination of the dietary value of the enrichment of corn meal.

Experiments conducted by one of the laboratories with grits and meal preparations other than corn bread were included in a previous report (25).

Standardizing Corn Bread Recipes

Standardized recipes were essential in the control of laboratory procedure within and among the five institutions, but also the corn bread must be acceptable to Texans. Therefore, Texans were

asked how they make corn bread. The first 85 recipes collected from Texas homes provided the basis for a corn bread recipe of family size. The 29 corn bread recipes collected from Texas college dormitories, hospitals and school lunchrooms were the basis for a quantity corn bread recipe.

The 85 home recipes were analyzed to show the amount of flour used to 1 cup of meal, of soda to 1 cup of sour milk, and the amount each of milk, egg, fat, sugar, salt and baking powder to 1 cup of meal or meal plus flour (30). Such wide variations were found in the proportion of ingredients that it was necessary to standardize three recipes, two made with sour milk, one of which contained flour, and one made with sweet milk and no flour. The standardized recipes use the modal proportions of ingredients, except that leavening is below modal.

All institutional recipes satisfied the requirement by definition that corn bread must contain more corn meal than flour. The standardized institutional-size recipe was developed from the 15 with the proportions of ingredients closest to the means of the 29 recipes collected.

Before the development of the family-size "Texas corn bread" recipes was completed and before a common supply of meal had been obtained, both Texas Technological College (Texas Tech.) and TSCW were ready for their laboratory work. Each developed a standard corn bread recipe for its own use. Texas Tech., the first to conduct experiments, developed a standard recipe for both a sweet milk-baking powder corn bread and a buttermilk-soda corn bread. TSCW used the analysis of the first 9 of the 85 home recipes received as the basis for their standard recipe.

The similarity of the standard home-size recipes is shown in Table 1. All institutions except NTSC contributed to this phase of the study. For laboratory use, the ingredients were weighed. The dry ingredients were sifted together. The milk was added to the beaten egg, and this mixture combined well with the dry ingredients. The fat was melted in the utensil in which the bread was to be baked, thus greasing it, and the surplus fat was stirred gently into the batter. The baking utensil was hot when the batter was poured into it. The family-size bread was baked in a hot oven, 419° F. (215° C.) at two institutions and 425° F. (218° C.) and 450° F. (232° C.), respectively, at the other two. Baking time was 30 minutes in three laboratories and 20 minutes in one laboratory. Institutional-size batches were baked at 400° F. (204° C.) for 30 minutes. Baking utensils included a 7¾-inch square thin tinned-iron layer cake pan, a 7-inch square tinned-iron pan 1¼ inches deep and a No. 6 iron skillet with an average diameter of 7½ inches. The batters lost 16 to 17 percent in weight during baking.

TABLE 1. INGREDIENTS IN THE STANDARDIZED CORN BREAD RECIPES FOR THE LABORATORY WORK AT EACH INSTITUTION

Ingredients[1]	Used by the Experiment Station and the University			Used by Texas Tech.		Used by TSCW	
	Sour milk		Sweet milk	Sour milk	Sweet milk	Sour milk	Sweet milk
	Without flour[2,3]	With flour[3]	Without flour[2]	Without flour		With flour	
						Family size	Institutional (130 servings)
	Weight of ingredients						
	Grams	Grams	Grams	Grams	Grams	Grams	Pounds
Corn meal	250	250	250	116	116	140	3 2/3
Flour		56				28	1 1/3
Milk	375	500	375	183	183	248	6.7
							Ounces
Baking powder	4.5	3.0	4.5		2.3	5.5	3 1/3
Soda	1.9	1.9		1.7		1.5	
Salt	6.0	6.0	6.0	4.0	4.0	3.0	1
Fat	24.0	24.0	24.0	25.0	25.0	12.0	10
Egg	48.0	48.0	48.0	48.0	48.0	48.0	11
	Measure of ingredients[4]						
Corn meal	2 c	2 c	2 c	1 c	1 c	1 c	2qt + 3 c
Flour		½ c				¼ c	5c + 5 T
Milk	1½ c	2 c	1½ c	¾ c	¾ c	1 c	3qt + 6 T
Baking powder	1½ t	1 t	1½ t		5/8 t	½ T	9 T
Soda	½ t	½ t		3/8 t		¼ t	
Salt	1 t	1 t	1 t	2/3 t	2/3 t	¾ t	2 1/3 T
Fat	2 T	2 T	2 T	2 T	2 T	1 T	1c + 7 T
Egg	1	1	1	1	1	1	7

[1]Sugar, which is optional in all recipes was not used in the laboratory corn bread.
[2]The Experiment Station.
[3]The University.
[4]c means cup; t, teaspoon; T, tablespoon.

Qualities	Good	Good	Fair	Poor	Poor
Appearance	1) Golden brown in color 2) Large volume, light 3) Crust slightly rough, small cracks				1) Spotted or pasty white 2) Small, compact, heavy 3) Smooth surface, large cracks
Texture	4) Crust crisp, moist, tender 5) Crumbly crumb 6) Well mixed with no white spots 7) Light, springy 8) Small air spaces				4) Crust hard, tough 5) Dry or doughy crumb 6) Spotted with flour or baking powder 7) Heavy, not springy 8) Large, coarse, uneven
Flavor	9) Sweet, nutty flavor 10) Well blended				9) Sour, flat, salty, alkaline 10) Not blended

Attitude: I like it._____ It's eatable._____ I dislike it._____

Name:_____

Region of state:_____

Figure 2. Score card for corn bread, developed and used by TSCW.

Quality of Corn Breads

Judging

The quality of corn breads made from the standardized recipes was judged with the aid of score cards developed for this purpose. The first two, one developed at TSCW and the other at Texas Tech., provided for a rating by check marks for "good," "fair" or "poor" for each of the specified characteristics. A description of each characteristic for "good" and "poor" was given in these score cards. The descriptions on the two cards were similar.

The TSCW card, Figure 2, was used by 657 Texans among the 1,612 students eating in dormitory dining rooms to judge the corn bread made by the standardized institutional recipe. For five regions of the State, 75 percent of the students' scores and comments placed the institutional corn

Judge's name_____ Date_____

Item	Characteristics: Description (If your score is not full value, check the description of characteristics which made you cut down the score.)		Score values: Full value	Score given: Range of scores in each class shown in ( ). Write specific value given. Do not check class value.		
	Poor	Good		Good (8-10)	Fair (5-7)	Poor (1-4)
Appearance	Smooth Very rough top Large cracks	Pleasantly rough Fine hairline cracks	10			
Color	Too dark Pasty white Off color Spotty	Golden brown Uniform Characteristic of ingredients	5	(4-5)	(3)	(1-2)
Grain	Too coarse Too compact Too fine Irregular	Typically coarse	5	(4-5)	(3)	(1-2)
Texture	Doughy	Granular crumb Crunchy crust	15	(12-15)	(8-11)	(1-7)
Moistness	Too dry Soggy	Slightly moist	5	(4-5)	(3)	(1-2)
Tenderness	Tough Hard Too crumbly	Tender	10	(8-10)	(5-7)	(1-4)
Flavor	Off flavor	Good Characteristic of corn meal	50	(40-50)	(26-39)	(1-25)
		Total score	100			

Figure 3. Score card for corn bread developed by Texas Tech. and revised by home economists at that college and at the Experiment Station.

bread in the good to excellent class. Only 57 percent of those from the El Paso region rated the corn bread that high. Probably the corn bread made with white meal for seving in the dormitories was less acceptable to many of the students from the El Paso region because they were accustomed to corn bread made with yellow meal.

The Texas Tech. score card was revised, Figure 3, jointly by home economists at that college and the Experiment Station. The main revisions were the introduction of "grain" as a characteristic and the assignment of a range of numerical values to each class of rating. This revised score card was used by the home economists who judged the corn breads made at the Experiment Station, by the food classes at NTSC and the University and by students at TSCW when the standardized family-size recipes were tested. A great majority of the scores were above 80, placing the corn bread in the "good" class.

Practical Testing

The family-size recipe was tested also in a practical way. The recipes for sour milk corn bread were mimeographed and distributed by the Texas Agricultural Extension Service to home demonstration agents and their club women. Every one who tried these recipes was requested to use the exact proportion of ingredients given and to follow carefully the directions for mixing and baking. No report was required, but comments were invited from all users of the recipes. Shortly after distribution, more than 70 voluntary responses had come in. These reports indicated that both corn breads—one with flour, the other without—were well liked, with nearly five times as many preferring the corn bread with flour. Two women said they liked more leavening; several wanted more salt and four preferred a baking temperature above 400° F. Many women mentioned improvement in their corn bread through the use of these recipes. The following comments are typical:

"It is a good recipe and I am going to keep on using it."

"I find your corn bread recipe very good and I like the way it's mixed, especially the egg and milk."

"I haven't made good corn bread since I married, but this recipe (without flour) is very good."

"Comment from my husband was, 'Why haven't you been making bread like this all the time?'."

"Without knowing I was using a different recipe, my husband commented at supper, 'This is the best corn bread you have ever made'."

These comments indicate that Texas homemakers are realizing that high-quality corn bread can be made with a third to a half as much leavening as many of them are accustomed to use.

Chemical Determination of Thiamine

Three of the laboratories—Texas Tech., the University and the Experiment Station—participated in the comparison through chemical determinations of the thiamine value of enriched and non-enriched corn meal and corn bread.

Materials Used

Except for the meal, each laboratory obtained all ingredients as needed at local groceries. Whole pasturized sweet milk and cultured buttermilk were used.

Texas Tech. used two commercial brands of corn meal, Everlite and Aunt Jemima, both as an enriched and a non-enriched product, from the local markets. The meals for the other two institutions were obtained from two milling establishments in Texas, as non-enriched products, partially or completely degermed. The white meal was supplied in 100-pound bags, the yellow in 50-pound bags.

Half of each lot of meal was enriched at the University or the Experiment Station, with a specially prepared mixture obtained first from the South Carolina Agricultural Experiment Station, later from Merck and Company. Both mixtures are called premix in this report. The premix to enrich each batch of meal was used in the amount expected to bring the content of vitamins to the level of federal standards (11). The premix was first sifted with a small portion of corn meal, then with successively larger amounts until, at the Experiment Station some 3 pounds, and at the University 10 pounds, of the meal had been used. This highly enriched meal was added gradually to the remainder of the meal in an institutional-size mixer and stirred for 2½ to 3 hours. Each batch of enriched meal and the corresponding non-enriched meal was divided among the laboratories which needed it at the time.

Indications that the laboratory procedure for enriching was satisfactory are: the good agreement between thiamine in the enriched meal found by analysis and the expected values calculated from the label information (3.04 versus 3.05 micrograms per gram, the University); comparable recoveries of the pure crystalline thiamine analyzed as a sample, and of the thiamine found in food samples supplemented with the pure vitamin (average 99.8 percent, range 92-106, and average 97.2 percent, range 98-112, respectively, Experiment Station); and vitamin value of the enriched meal (Merck premix) within the range of federal standards.

Sampling

At Texas Tech. each package of the commercial meals was well mixed before sampling for analysis and using to make corn bread.

At the University, to get a sample of the enriched corn meal for analysis, approximately 50 grams were placed on a large sheet of wax paper

and rolled, that is a corner of the sheet was pulled over the top of the material as far as possible without spillage; this was repeated with each of the other three corners and the entire process repeated six times. The pile of material was then flattened and divided into quarters with a spatula. Two opposite quarters were discarded and the rolling repeated. This process of rolling and quartering was repeated two more times and a 5-gram sample was weighed carefully for analysis.

The Experiment Station employed a quartering technique similar to the University's, using brown wrapping paper and an amount of meal (700 grams) sufficient to provide corn meal samples and a batch of corn bread. The 5-gram samples of meal were each placed in a 100-milliliter volumetric flask into which 25 milliliters of extractant previously had been pipetted.

In all laboratories, the samples of batter were taken immediately after mixing; the remainder of the batter was placed in the preheated oven as soon as possible. At the University, 10-gram samples of batter were carefully weighed on the analytical balance and transferred quickly to the extraction flask. The batter samples at the Experiment Station were weighed on the trip balance into a shallow drying dish and covered immediately. Each covered sample was then weighed precisely on the analytical balance and transferred through a funnel to a 100-milliliter volumetric flask for extraction.

The corn bread was cooled to room temperature (about 1½ hours) before sampling. The loaf was quartered; each quarter cut into three wedges; and the center wedge of each quarter was used for the samples.

At the University, the corn bread wedges were crumbled thoroughly by hand, particular attention being given to breaking the crust and distributing it well through the crumb. The Experiment Station used first a Moule rotary grater to crumble each wedge, then passed the crumbled bread through a wire sieve. The finely divided corn bread from the four wedges was mixed thoroughly, first with a spoon, then by rolling on wax paper, then placed in a drying dish and covered. Ten-gram samples were weighed immediately on the analytical balance and each was transferred through a funnel into a 100-milliliter volumetric flask.

Method of Analysis

Each laboratory followed in general the directions of Hennessy (13) for thiochrome assay of cereal products. Texas Tech. used the simplification of the thiochrome method proposed by George W. Schiller (21). The Experiment Station made two modifications in the extraction procedure based on preliminary findings as well as on results reported from other laboratories (3, 19). The base exchange purification was omitted, and instead of .1N H_2SO_4 for extraction, 1 percent acetic acid was used first; later when riboflavin and niacin also were determined (25), a sodium acetate buffer solution was used. As digestion enzyme, Texas Tech. used takadiastase; the University, clarase; and the Experiment Station, a mixture of takadiastase and papain.

Results and Discussion of Chemical Studies

Thiamine Content of Meals

The thiamine values of the several meals used are summarized in Table 2. The increase in thiamine content of the enriched meals over the non-enriched with which each is to be compared, ranges from a third to over five times the content of the non-enriched. The first three premixes used for meal enrichment were lower in thiamine content than the fourth premix; the differences are reflected in the enriched meals. The variation in content of non-enriched meals is illustrated by their range of values—1.00 to 1.98 mcg/g for the meals used at the University and Experiment Station, and .94 and 2.92 mcg/g for the two commercial brands used by Texas Tech. Non-enriched values depend on the natural thiamine content of the corn and the extent to which vitamin-bearing portions of the grain are removed in milling. Hence, the thiamine content of the non-enriched meal makes a variable contribution to the value of the corresponding enriched meal.

TABLE 2. THIAMINE CONTENT OF CORN MEALS

Kind of meal	Mcg/g wet basis[1]					
	Non-enriched			Enriched		
	No. replications	Range	Av.	No. replications	Range	Av.
Texas Tech.						
White						
Everlite	2	2.92 2.93	2.92	3	3.38 3.76	3.59
Aunt Jemima	2	.92 .96	.94	2	4.18 4.56	4.37
The University[2]						
White						
Premix 1	6		1.00			3.05
The Experiment Station[2]						
White						
Batch 1 Premix 1	4	1.64 1.82	1.73	7	2.45 2.56	2.53
Batch 2 Premix 2	6	1.96 2.01	1.98	17	2.21 2.57	2.34
Premix 3				11	2.37 2.86	2.60
Batch 3 Premix 4	3	.96 1.06	1.00	3	4.53 4.65	4.59
Yellow						
Batch 1 Premix 3				12	2.28 2.60	2.50
Batch 2 Premix 3				3	2.93 3.13	2.98

[1]Wet basis means raw batter and baked corn bread, i.e. no drying.
[2]Corn meals were enriched by the Experiment Station or the University.

The source of corn for the two brands of commercial meals is not known. Probably enriched and non-enriched meal of each brand were not from the same corn, since the non-enriched Everlite had more thiamine than non-enriched Aunt Jemima; but enriched Aunt Jemima exceeded enriched Everlite in thiamine content.

Thiamine Content of Corn Breads

Corn bread made only by standardized recipes was used for chemical determination of thiamine. Texas Tech. used its own recipes, one for sweet milk, the other for sour milk. Both types of bread were made with the enriched and the non-enriched meal of each of two commercial brands. The University and the Experiment Station each used two of the recipes standardized from the analysis of the 85 home recipes. The University compared enriched breads made with and without flour. The Experiment Station made sour milk bread with non-enriched and with the corresponding enriched meals, and sweet milk bread with enriched meal.

The results of determination of thiamine in the corn breads are shown in Table 3 in terms of mcg/g on both the dry and the wet basis, that is for the latter, as eaten. With the exception of sour milk bread with flour, the corn breads on the dry basis have a lower thiamine content per gram than the raw meals used to make them (Tables 2 and 3, Texas Tech. and the University) even though the milk and eggs contributed to the thiamine content. Not only was thiamine lost in baking, but also the dry weight includes other ingredients of the bread.

Still greater differences between the raw meals and the breads made from them are seen for the corn breads on the wet basis (Tables 2 and 3, Experiment Station). This is because of the greater moisture content of the bread and to loss in baking. In four of the six comparisons that can be made of an enriched bread with one non-enriched (wet basis), the enriched has from half to three times more thiamine content. For Everlite, the difference is small for sweet milk bread, negligible for sour milk. This reflects the smaller increase in thiamine due to enrichment of Everlite than of Aunt Jemima (Table 2).

Thiamine Retention in Corn Breads

Thiamine retention was determined by comparing the contents of the batter and the resultant bread. Calculations on the dry basis with per

TABLE 3. THIAMINE CONTENT OF CORN BREAD

Kind of corn bread	Mcg/g wet basis						Mcg/g dry basis[1]			
	Non-enriched			Enriched			Non-enriched		Enriched	
	No. replications	Range	Av.	No. replications	Range	Av.	Range	Av.	Range	Av.
Texas Tech.										
Sour milk										
Everlite	3	1.35 1.44	1.40	2	1.35 1.51	1.43	2.24 2.29	2.26	2.19 2.53	2.36
Aunt Jemima	2	.55 .62	.58	2	1.76 1.82	1.79	.96 1.04	1.00	2.62 2.86	2.74
Sweet milk										
Everlite	4	1.28 1.58	1.40	2	1.56 1.58	1.57	1.98 2.36	2.13	2.40 2.45	2.42
Aunt Jemima	3	.65 .75	.68	2	1.70 1.91	1.80	1.04 1.19	1.10	2.87 3.00	2.94
The University										
Sour milk										
Made without flour		No data		3	1.37 1.47	1.42	No data		2.50 2.63	2.58
Made with flour		No data		3	1.67 1.74	1.70	No data		3.09 3.34	3.18
The Experiment Station										
Sour milk										
White meal										
Batch 1 Premix 1	3	.91 .99	.94	4	1.17 1.25	1.22	No data			
Batch 2 Premix 2	3	.92 1.00	.97	3	1.12 1.12	1.12	No data			
Yellow meal Premix 3		No data		4	.83 1.29	1.06	No data			
Sweet milk										
White meal Premix 3		No data		4	1.07 1.20	1.13	No data			
Premix 4		No data		5	1.79 1.97	1.91	No data			

[1]Dry basis values were calculated from corresponding wet basis values and moisture content.

gram values were made by Texas Tech. and the University, using the following equations:

$$\% \text{ moisture} = \frac{\text{weight loss}}{\text{sample weight}} \times 100$$

$$\text{Wet basis to dry basis: } \frac{\text{mcg/g wet basis}}{\dfrac{1.00 - \% \text{ moisture}}{1.00}} = \text{mcg/g dry basis}$$

$$\% \text{ loss} = \frac{\text{mcg/g batter} - \text{mcg/g bread}}{\text{mcg/g batter}} \times 100$$

$$\text{Retention} = 100\% - \% \text{ loss}$$

The Experiment Station made calculations on the wet basis using total batch values. Equations were:

Batter: total grams × its mcg/g thiamine = total mcg in batch of batter.

Bread: total grams × its mcg/g thiamine = total mcg in resultant bread.

$$\frac{\text{Total mcg in bread}}{\text{Total mcg in batter}} \times 100 = \% \text{ retention}$$

Both methods are predicated on the assumptions that all of the thiamine is in the dry matter of both batter and bread, and that the only loss while baking that can be determined by weight, is moisture. The results by the two methods of calculations used are comparable. The values will be identical if the equivalence between 1 gram of batter and 1 gram of resultant bread is determined and used in the calculation on the dry basis.

In contrast to the variation in *thiamine content* within the non-enriched and the enriched groups of corn breads shown in Table 3, is the marked similarity in the *percentage retentions* shown in Table 4. The breads made in two laboratories with laboratory-enriched meals showed retentions ranging from 84.0 to 90.3 percent, and averaging 86.8 percent. The thiamine in the bread as a percentage of that in the batter was approximately the same whether the bread was made with enriched or non-enriched meal, yellow meal or white meal, sour milk or sweet milk, with or without flour, or the meal was enriched with different premixes.

The retentions of thiamine by breads made with the commercial meals also are similar. Including one somewhat variant value (66.4 percent), the average of eight retentions, (highest of which is 78.4 percent), is 73.7 percent. No important difference was found between retentions by non-enriched and enriched bread, (average 72.8 versus 74.7 percent), nor between the brands of meal, (Everlite average 74.0 percent, Aunt Jemima 73.4 percent), However, the retentions by these sweet milk corn breads are consistently slightly greater (average 77.6 percent) than the sour milk breads (average 69.9 percent).

An explanation for the contrast in the retention of thiamine in sweet milk versus sour milk breads reported by Texas Tech. and the Experiment Station is shown in Table 5. The data for the Experiment Station are taken from a separate investigation on the relation of pH to retention of B vitamins in corn bread (18). The lower pH values of batter and bread are associated with the higher retentions. This is true both within and among laboratories. Different breads were used by Texas Tech. for the determination of pH values and of retention, but the same recipe was used for both purposes. The pH values and retention were determined on the same bread and its batter in each baking at the Experiment Station. Data from both laboratories indicate that if the baking powder is sufficiently balanced, the pH of the bread is little, if any, higher than of the preceding batter. But with soda, the 3.4 grams to 1½ cups of sour milk used by Texas Tech., resulted in a pH of 6.9 for batter and 7.3 for bread; whereas the 1.9 grams of soda to 1½ cups of sour milk used by the Experiment Station gave a pH of 5.8 for batter and of 6.0 to 6.2 for bread.

Increasing the amount of soda, from 1.9 to 6.0 grams in the standardized sour milk recipe for

TABLE 4. RETENTION OF THIAMINE IN CORN BREAD

Kind of corn bread	Non-enriched			Enriched		
	No. replications	Retention[1], % Range	Av.	No. replications	Retention, % Range	Av.
Texas Tech.						
Sour milk						
Everlite	3	70.2 73.8	72.1	2	69.3 71.1	70.2
Aunt Jemima	2	65.8 67.1	66.4	2	68.0 73.7	70.9
Sweet milk						
Everlite	4	69.8 79.9	74.1	2	79.5 79.8	79.6
Aunt Jemima	3	73.2 81.5	78.4	2	77.3 78.8	78.1
The University						
Sour milk						
Made without flour				3	87.2 89.0	87.1
Made with flour				3	85.0 85.9	85.5
The Experiment Station						
Sour milk						
White meal						
Batch 1 Premix 1	3	87.2 88.5	87.6	4	87.4 90.5	88.6
Batch 2 Premix 2	3	85.4 87.2	86.2	3	88.5 92.2	90.3
Yellow meal Premix 3				4	83.0 89.2	86.3
Sweet milk						
White meal						
Premix 3				4	81.8 86.7	84.0
Premix 4				5	82.4 89.2	85.1

[1]Calculated on the dry basis with per gram values by Texas Tech. and the University; on the wet basis with total batch values by the Experiment Station.

Figure 4. This size loaf, 7½ inches diameter and 1 inch thick, provides 130 grams (4.6 ounces) of corn bread for each of four persons at one meal.

corn bread (18) produced successively higher pH values of batter and bread, and successively smaller thiamine retentions. With pH of batters 6.0 and below, the pH of corresponding breads did not exceed 6.6 and retentions were good (80 to 89 percent). With pH of batters 6.25 to 6.6, the pH of the resultant breads ranged from 7.2 to 8.9 and retentions fell precipitately to 3 percent or none.

While percentage retention is greatest when excessive soda is avoided in making corn bread, the absolute amount of thiamine in the bread will be greater as the amount in the batter is greater.

Dietary Contribution

Three laboratories, TSCW, the Experiment Station and NTSC tested the practical value of enriching corn meal. TSCW and the Experiment Station used evaluation of the nutrient content of corn bread and NTSC compared enriched and non-enriched corn breads in dietary studies.

The standardized family-size corn bread loaf made at TSCW was smaller (average weight 390 grams) than the standardized loaf based on the 85 home recipes (average weight 517 grams) used at the Experiment Station. But with the smaller loaf considered a typical size for a family of three for one meal, and the larger loaf for four persons, the average amount consumed per person per meal is counted as 130 grams. The amount of bread for one person at a meal as estimated in this study is shown in Figure 4.

Only corn bread made with Merck enriched meal was used for estimating the content of thiamine in the bread. The thiamine content of this meal was 4.59 mcg/g. The bread averaged 1.925 mcg/g of thiamine. The amount of thiamine supplied per person at one meal would be 130 x 1.925 mcg, or 250 mcg (0.250 mg). This amount of thiamine as percentages of the 1953 revised recommended allowances for adults in the United States (17) follows:

MEN			WOMEN		
Age	Allowance, mg	Percentage of allowance	Age	Allowance, mg	Percentage of allowance
25	1.5	16.6	25	1.1	22.7
45	1.3	19.2	45	1.0	25.0
65	1.2	20.8	65	1.0	25.0

Enriched corn bread is an important source of thiamine, furnishing at a single meal 17 to 25 percent of the recommended daily allowance of this vitamin. The importance is indicated also by the following considerations. One of the Tex-

TABLE 5. THIAMINE RETENTION IN CORN BREAD IN RELATION TO pH OF BATTER AND OF BREAD

Kind of corn bread[1]	No. replications	Grams of leavening to 1½ c milk		pH				Retention, %	
				Batter		Bread			
		Soda	Baking powder	Range	Av.	Range	Av.	Range	Av.
Experiment Station[2]									
Sour milk Standard	11	1.9	4.5	5.4 6.0	5.81	6.1 6.2	6.2 (4 breads)	83.2 92.2	87.9
Sweet milk Standard	9	0	4.5	6.0 6.2	6.07	6.4 6.5	6.46 (5 breads)	81.8 89.2	84.7
Sour milk	2	1.9	0	5.8 only		6.0	(1 bread)	83.0 87.0	85.0
Texas Tech.									
Sour milk	9	3.4	0	6.9 7.0	6.9	7.2 7.4	7.3	65.8 73.8	70.6
Sweet milk	11	0	4.6	6.7 7.0	6.9	6.7 7.0	6.9	69.8 81.5	78.8

[1]Enriched meal only in breads at the Experiment Station; both enriched and non-enriched at Texas Tech.

[2]Data from separate investigation by the Experiment Station on the relation of pH to retention of B vitamins in corn bread (18).

as surveys (14) showed the average annual consumption of corn meal among 140 families distributed over the State was 1.2 pounds per person per month; whereas, in one county where records were kept by housewives, the average was 2 pounds per person per month. The United States average is 1.8 pounds of corn meal per month (27.28) and large groups of people in Texas exceed that amount. Such consumption implies that corn meal with a caloric value of 1.650 and protein 35 to 41 grams per pound probably furnishes to many Texans each month the equivalent of sufficient energy and protein for more than a day.

In Texas, corn bread frequently is eaten at more than one meal, especially by rural families. The value of enriched corn bread as a food is correspondingly multiplied. However, the benefit from thiamine in sour milk bread depends on not using too much soda. The milk and eggs in corn bread increase the content of minerals, especially calcium, phosphorus and iron, and along with meal enrichment make enriched corn bread two times as rich in thiamine, one and one-half times in riboflavin and three times in niacin as the non-enriched (25). The milk and eggs also provide high quality protein which supplements the very low tryptophane content of corn meal (15).

Corn bread eaten frequently contributes indirectly to the nutritive value of the diet through the foods which many Texans think "go with" corn bread. According to the 102 North Texas families in Collin county (34), the five most preferred food combinations for serving with corn bread are: red beans and green onions, blackeye peas and greens, turnips with turnip greens, green beans and tomatoes and cabbage with ham hock. In Mississippi (9), both white and Negro families served corn bread with green leafy vegetables, especially turnip greens, collards and cabbage, and to a lesser extent peas, beans and buttermilk. Some of these accompanying foods contribute vitamins other than of the B group; others supply amino acids which are low in corn meal.

Corn Meal in the Diet of Texas College Women

This study included 22 young college women, 11 of each group identified as "North" and "South" according to the part they occupied of the home management duplex at NTSC. The diets were planned by the two groups of college women for three 5-day periods. Both groups used the same menus for a 5-day period, each group purchasing its own food supply. All the bread and flour used by both groups was enriched. The corn meals used, both enriched and the corresponding non-enriched, were furnished by the Research Committee of the Texas State Nutrition Council. Each day a serving of corn bread was eaten at one of the meals. One group (South) used non-enriched corn meal while the other group (North) used the enriched for making corn bread by the standardized recipe with sour milk, and no flour. The methods of cooking the other foods were not standardized, varying with the experience and techniques of the individual cooks. A composite sample representing each day's menus was collected in a weighed jar at the same time that the subjects were served at the table. The sample consisted of a serving of each food from each meal similar in all respects to that eaten by the women. One-fourth glass of milk was collected daily in a similar manner, thus giving one homogenous milk sample for each 5-day period. A record was kept of the number of glasses of milk consumed by each subject each day since this was the only variable in the daily food intake. All samples were refrigerated until analyzed. The total daily intake of thiamine was considered to be the sum of the content in the milk and in the composited food samples for the day.

The thiamine content of the food was determined by using the Connor and Straub method (8), with modifications from the Association of Vitamin Chemists (5) and Gyorgy (12) in converting thiamine to thiochrome.

The determined thiamine values of the daily composite food samples including milk, are:

SOUTH GROUP Non-enriched corn bread	NORTH GROUP Enriched corn bread
mg	mg
1.06	2.26
1.14	0.90
1.07	1.18
1.07	1.70
1.73	1.00
0.41	0.51
0.82	0.84
0.74	0.65
0.70	1.08
1.00	0.91
0.33[1]	0.69[1]
Average 0.92	1.07

[1]For a 5-days' composite food supply instead of daily composite.

All food samples were analyzed separately except for one 5-day period, as shown in the preceding footnote, when it was not possible to keep the daily composites for separate analysis because of limited refrigerator space. The inclusion of one serving a day of enriched corn bread by the North group did not give consistently higher daily values for this group. However, the average of all such diets was slightly higher, being 1.07 versus 0.92 milligrams of thiamine for the South group with the non-enriched corn bread.

Thiamine is destroyed in many cooking processes. The methods used in the preparation of these diets, with the exception of the corn bread, were not standardized, which was another variable. However, these thiamine values suggest that even the slight increase in the daily thiamine content represented by one serving of a food made

TABLE 6. SUMMARY OF GRAMS OF GAINS BY RATS FED ONLY CORN BREAD MADE OF DEGERMED AND WHOLE GRAIN MEALS BOTH ENRICHED AND NON-ENRICHED

Sex	Enriched		Non-enriched	
	Degermed	Whole grain	Degermed	Whole grain
Males	211	167	186	174
	185	185	135	148
	178	175	148	137
Av.	191.3	175.7	156.3	153.0
Females	155	94	114	105
	111	129	112	107
	109	100	117	100
Av.	125.0	107.7	114.3	104.0
Males + females	949	850	812	771
Av.	158.2	141.7	135.3	128.5
Grand sum	1799		1583	
Grand av.[1]	149.9		131.9	

[1] F = 7.56. Significant at the 5% level.

Sig. F: 1% = 8.53
5% = 4.49

with an enriched cereal definitely adds to the total daily thiamine intake.

Bioassay of Thiamine in Corn Bread

At TSCW, rats which had been depleted of thiamine were the test animal for comparing non-enriched and enriched corn bread as a source of this vitamin. Growth was the criterion for evaluation of the results. In the first of three series of experiments, the degermed and whole grain corn meals were obtained from a milling firm in Birmingham, Alabama. For two later studies, either the University or the Experiment Station supplied the corn meal. Both enriched and non-enriched meals were used when corn bread alone constituted the diet in the experiments with degermed and whole grain meals, also when corn bread of Texas meals supplemented a basal diet. But products made of enriched meal only were fed for the comparison of baked and unbaked bread. The corn bread was made by the family-size recipe standardized at TSCW.

The rats were fed corn bread over a 5-week period in one of three ways—as the entire *ad libitum;* as a supplement to a basal thiamine-free diet in graduated amounts, (6, 4 and 2 grams daily except Sundays) ; and as baked versus unbaked corn bread *ad libitum* as the entire diet. Six rats, three males and three females, were in each segment of each series of experiments.

Records were kept of weight at weaning, weight at depletion, final weight and food consumption. The gains in weight, *i.e.* final weight minus weight at depletion, are shown in Tables 6 and 7 to compare enriched and non-enriched corn breads. Table 8 contains gains and total food consumption in the experiments to compare corn bread with batter made by the same recipe. These data were analyzed statistically.

Considering degermed and whole grain corn bread together (Table 6), the 12 rats on the enriched diet averaged a gain of 149.9 grams, an excess of 18.0 grams over the 131.9 grams of the 12 rats on non-enriched corn bread. The difference is significant at the 5 percent level. Similarly, considering the three levels of corn bread supplement (Table 7), the superiority of the enriched diet is shown by a significant difference of 16.1 grams in average gain for the 18 rats in each category, (average 123.2 versus 107.1 grams). The greater efficiency of the two higher levels of corn bread is seen in the downward trend of

TABLE 7. SUMMARY OF GRAMS OF GAIN BY RATS FED A BASAL DIET SUPPLEMENTED AT ONE OF THREE LEVELS OF ENRICHED OR NON-ENRICHED CORN BREAD

Sex	Level of corn bread supplement					
	6 grams		4 grams		2 grams	
	Enriched	Non-enriched	Enriched	Non-enriched	Enriched	Non-enriched
Males	92	64	110	76	76	82
	114	96	74	60	52	51
	126	103	111	70	38	68
Av.	110.7	87.7	98.3	68.7	55.3	67.0
Females	71	59	89	74	33	34
	86	109	70	65	72	58
	107	64	96	84	62	68
Av.	88.0	77.3	85.0	74.3	55.7	53.3
Males + females	596	495	550	429	333	361
Av.	99.3	82.5	91.7	71.5	55.5	60.2
Enriched + non-enriched	1091		979		694	
Av.[1]	90.9		81.6		57.8	

[1] F = 13.07. Significant at the 1% level.

Sig. F: 1% = 5.61
5% = 3.40

gains which was accelerated with successive reductions in the supplement. The difference between the 6 and 2-gram supplements accounts for 94 percent of the sum of squares of the levels.

The gains on degermed enriched corn bread were consistently greater than on the whole grain (Tables 6 and 8); however, the differences were not statistically significant. Neither series of experiments showed a significant difference in food consumption. A possible explanation for the better gain on degermed bread may be the greater digestibility associated with its lower fiber content; but there are no findings in this study to support such an assumption.

The gains on baked bread versus batter (Table 8) were not significant; yet the average weight of batter eaten was only 60.4 percent of the weight of the baked bread consumed. Similar gains on bread and batter are explained partly by the greater content of thiamine per gram of batter than per gram of bread. Better utilization of the uncooked product also is a possibility.

In 11 of the 13 comparisons, the gains of the males exceeded those of the females (Tables 6, 7 and 8). Differences in the other two instances are small, 0.4 and 5.6 grams.

Whether degermed or whole corn meal was used as the only food in the diet, or the degermed was used as a supplement to a basal diet, the results of the bioassays confirm the superiority of the enriched over the non-enriched corn breads indicated by chemical analyses.

TABLE 8. SUMMARY OF GRAMS OF GAIN AND FOOD CONSUMPTION BY RATS FED BAKED AND UNBAKED ENRICHED CORN BREAD

Sex	Baked		Unbaked degermed
	Whole	Degermed	
Gain			
Males	167	211	162
	185	185	162
	175	178	173
Av.	175.7	191.3	165.7
Females	94	155	115
	129	111	132
	100	109	131
Av.	107.7	125.0	126.0
Males + females Av.[1]	850 141.7	949 158.2	875 145.8
Food consumption			
Males	1072	1060	558
	969	948	578
	1139	833	518
Av.	1060.0	947.0	551.3
Females	720	951	535
	831	889	655
	819	660	447
Av.	790.0	833.3	545.7
Males + females Av.[2]	5550 925.0	5341 890.2	3291 548.5

[1] F = 1.72. Not significant.

[2] F = 26.30. Significant at the 1% level.

Sig. F: 1% = 6.93, 5% = 3.88

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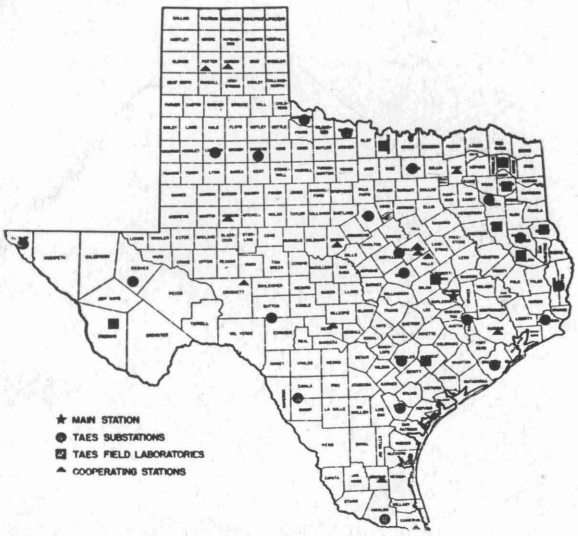

Location of field research units in Texas maintained by the Texas Agricultural Experiment Station and cooperating agencies

State-wide Research

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The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of nine parts of the Texas A&M College System

IN THE MAIN STATION, with headquarters at College Station, are 16 subject-matter departments, 2 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 21 substations and 9 field laboratories. In addition, there are 14 cooperating stations owned by other agencies, including the Texas Forest Service, the Game and Fish Commission of Texas, Texas Prison System, the U. S. Department of Agriculture, University of Texas, Texas Technological College and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

RESEARCH BY THE TEXAS STATION is organized by programs and projects. A program of research represents a coordinated effort to solve the many problems relating to a common objective or situation. A research project represents the procedures for attacking a specific problem within a program.

THE TEXAS STATION is conducting about 350 active research projects, grouped in 25 programs which include all phases of agriculture in Texas. Among these are: conservation and improvement of soils; conservation and use of water in agriculture; grasses and legumes for pastures, ranges, hay, conservation and improvement of soils; grain crops; cotton and other fiber crops; vegetable crops; citrus and other subtropical fruits, fruits and nuts; oil seed crops—other than cotton; ornamental plants—including turf; brush and weeds; insects; plant diseases; beef cattle; dairy cattle; sheep and goats; swine; chickens and turkeys; animal diseases and parasites; fish and game on farms and ranches; farm and ranch engineering; farm and ranch business; marketing agricultural products; rural home economics; and rural agricultural economics. Two additional programs are maintenance and upkeep, and central services.

RESEARCH RESULTS are carried to Texas farm and ranch owners and homemakers by specialists and county agents of the Texas Agricultural Extension Service.